

Summary and Next Steps

Climate change is a complex, long-term challenge. United States' climate change goals are consistent with and supportive of the United Nations Framework Convention on Climate Change (UNFCCC), which set an ultimate goal of stabilizing greenhouse gases (GHGs) in the atmosphere at a level that avoids dangerous human interference with the climate system. There is international recognition that climate change concerns cannot be

addressed in isolation from other pressing needs, such as economic development, energy security, and pollution reduction, especially in developing economies. Successfully addressing these complementary concerns will require the development and commercialization of advanced technologies, particularly, but not exclusively, those that have the potential to fundamentally alter the way we produce and use energy. It will also require a sustained, long-term commitment by all nations over many generations and a substantial degree of international cooperation.

It is within this broad context that the United States is pursuing a comprehensive strategy on climate change. This strategy includes implementing policies and measures to slow the growth of GHG emissions, investing in climate science to improve understanding of climate change and provide information to decision-makers, accelerating the development and adoption of energy and other technologies that reduce, avoid, or capture and sequester GHG emissions, and promoting international collaboration. In this way, the United States is working to ensure a bright and secure energy and economic future for the Nation and a healthy planet for future generations (Figure 10-1).

Under the auspices of the Cabinet-level Committee on Climate Change Science and Technology Integration (CCCSTI), the Climate Change Technology Program (CCTP), led by the Department of Energy (DOE), represents the technology component of this strategy. Authorized by the Energy Policy Act of 2005, CCTP functions as a multi-agency planning and coordination entity. CCTP is charged with reviewing and prioritizing the Federal Government's climate-related technology programs. Its activities are guided by the CCCSTI and carried out by representatives of the participating R&D agencies. CCTP provides strategic direction for and coordinates an investment portfolio of climate-change



Figure 10-1. The United States is working to ensure a bright and secure energy and economic future for the Nation and a healthy planet for future generations.

Courtesy: NASA, Hasler Laboratory for Atmospheres
Goddard Space Flight Center, Credit: Nelson Stockli

related technology research, development, demonstration and deployment (R&D) of nearly \$3 billion in Fiscal Year 2006.

10.1 Summary

The CCTP *Strategic Plan* is an important milestone on the road to accelerating the development and adoption of advanced climate change technologies. The *Plan* articulates a vision for the role for advanced technology in addressing climate change concerns, provides a supporting long-term planning context with insights from analysis, and establishes goals, approaches, and guiding principles for Federal R&D agencies to use in formulating climate change-related technology components of their respective R&D portfolios.

CCTP’s strategic vision is to attain, on a global scale and in partnership with others, a technological capability that can provide abundant, clean, secure, and affordable energy and other services needed to encourage and sustain economic growth, while simultaneously achieving substantial GHG emissions reductions to mitigate the potential risks of climate change from increasing GHG concentrations. To give substance to this vision, CCTP’s portfolio pursues six complementary strategic goals: (1) reduce emissions from energy use and infrastructure; (2) reduce emissions from energy supply; (3) capture and sequester CO₂; (4) reduce emissions of other GHGs; (5) measure and monitor emissions; and (6) bolster the contributions of basic science. The *Plan* outlines seven approaches to attain those goals, including next steps.

Long-Term Planning Under Uncertainty

CCTP operates within a planning environment characterized by uncertainty. First, the complex relationships among population growth; economic development; energy demand, mix, and intensity; resource availability; technology advancement; and many other societal variables make it difficult to estimate with confidence future global GHG emissions over CCTP’s long-term planning horizon. This creates uncertainty about the scope and scale of

the technological challenge. Second, evolving climate science, as well as the uncertain nature of the (as yet undetermined) UNFCCC’s stabilization objective, adds uncertainty about the appropriate pace of technology development. Finally, research and development itself is risky, such that the future readiness, cost, and performance characteristics of the many advanced technologies envisioned to facilitate GHG emissions reductions are unknown. This adds uncertainty about deployment and which, if any, technologies will ultimately emerge as successful.

Goals for Technology Development

Uncertainties notwithstanding, CCTP sets ambitious goals for technology development in each of its strategic areas. By addressing uncertainties systematically through analyses of options, or scenarios, under a range of varying assumptions, CCTP can illuminate its technological challenges in the form of bracketed insights regarding reductions or avoidances in GHG emissions, comparative costs, and the timing of significant technology adoption. These insights, in turn, can be used to guide R&D portfolio planning, as well as inform specific near-, mid- and long-term technological development objectives.

Regarding reductions or avoidances in GHG emissions, CCTP envisions significant contributions

Estimated Cumulative GHG Emissions Mitigation (GtC) from Accelerated Adoption of Advanced Technologies over the 21st Century, by Strategic Goal, Across a Range of Hypothesized GHG Emissions Constraints

CCTP STRATEGIC GOAL	VERY HIGH CONSTRAINT ¹	HIGH CONSTRAINT	MEDIUM CONSTRAINT	LOW CONSTRAINT
GOAL #1. Reduce Emissions from Energy End Use & Infrastructure	250 - 270	190 - 210	150 - 170	110 - 140
GOAL #2. Reduce Emissions from Energy Supply	180 - 330	110 - 210	80 - 140	30 - 80
GOAL #3. Capture and Sequester Carbon Dioxide	150 - 330	50 - 140	30 - 70	20 - 40
GOAL #4. Reduce Emissions of Non-CO₂ GHGs	160 - 170	140 - 150	120 - 130	90 - 100

Table 10-1. Estimated Cumulative GHG Emissions Mitigation (GtC) from Accelerated Adoption of Advanced Technologies over the 21st Century, by Strategic Goal, Across a Range of Hypothesized GHG Emissions Constraints².

¹ A “very high constraint” scenario is associated with low GHG emissions and low GHG concentrations. A “low constraint” scenario is associated with higher GHG emissions and concentrations.

² Source: Clarke et al. 2006, as described in Chapter 3. The 100-year cumulative values shown are consistent with Figure 3-19. Values have been rounded to the nearest 10 GtC.

from the accelerated adoption of advanced technologies in each of its four emissions-reduction strategic goals.³ Across a wide range of atmospheric GHG concentration levels and hypothesized emissions constraints (from “low” to “very high”), CCTP explored the potential contributions of three contrasting technological futures over a 100-year planning horizon. Table 10-1 provides a representative sample of the range of GHG emissions reductions, accumulated over this period, that may be possible should the promise of advanced technologies associated with these goals be realized (see Chapter 3).

Across all four goals, as well as among the many technologies within each goal, the accelerated adoption of advanced technologies is shown to be potentially capable of contributing significantly to GHG emissions reductions and avoidances. The underlying assumptions for technology performance can help inform long-term technology R&D planning and goal-setting. The significance of the potentials across all four goals suggests the importance of pursuing a diversified R&D portfolio.

Potential to Reduce Mitigation Costs

CCTP analysis suggests that significant economic benefits could accrue, if advanced technologies with high emission mitigation potentials were to be successfully deployed. Figure 10-2 presents the results of a comparative analysis of the cumulative costs over the 21st century of GHG mitigation, with and without the accelerated adoption of advanced technologies, across a range of advanced technology scenarios and variously hypothesized GHG emissions constraints. The relative cost reductions are significant in all cases. As one would expect, the absolute cost reductions are more significant under the higher emissions constraints.⁴ The results of modeling these hypothetical scenarios suggest the potential for advanced GHG-reducing technologies to reduce mitigation costs.

Considerations of Timing

With regard to considerations of timing and commercial readiness of the advanced technology options, insights were gained by analysis of the lowest

Comparative Analysis of Estimated Cumulative Costs Over the 21st Century of GHG Mitigation, With and Without Advanced Technology, Across a Range of Hypothesized GHG Emissions Constraints

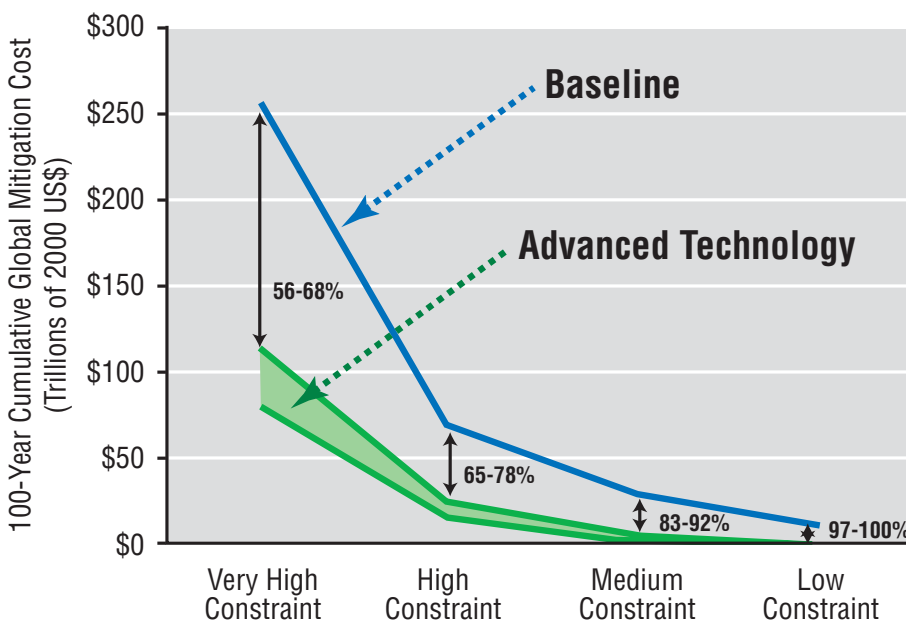


Figure 10-2. Comparative Analysis of Estimated Cumulative Costs Over the 21st Century of GHG Mitigation, With and Without Advanced Technology, Across a Range of Hypothesized GHG Emissions Constraints.

³ Non-CO₂ GHGs include a diverse group of gases, such as methane, nitrous oxide, and chlorofluorocarbons. They are expected to contribute as much as 20 percent to total radiative forcing throughout the 21st century.

⁴ In the associated analysis (Chapter 3), the cumulative costs over the 21st century are undiscounted. Accordingly, relative comparisons (percents) are likely to be more meaningful than those showing absolute costs. Variations among the advanced technology scenarios are shown by the shaded area in Figure 10-2.

cost solutions across a range of technology scenarios and hypothesized GHG concentration levels. Generally speaking, the lower the level of GHG concentrations hypothesized, the earlier the need for the commercial readiness of the advanced technologies.

Using the metric of when the first GtC per year of reduced or avoided GHG emissions could be achieved by the accelerated adoption of advanced technologies, across a range of assumptions, scenarios, and GHG emissions constraints, the analysis indicates that, in relative terms, advanced technologies for end-use energy efficiency contribute first, followed soon thereafter by technologies for mitigation of non-CO₂ GHGs, advanced energy supply technologies, and carbon capture, storage, and sequestration. The timing of such contributions for each CCTP strategic goal, however, may vary by decades depending on the GHG concentration level assumed, as shown in Table 10-2. Allowing for capital stock turnover and other inertia inherent in the global energy system and infrastructure, it is noted that for advanced technologies to achieve one GtC per year, they would need to be available in the commercial marketplace and gaining market share years before the periods indicated on Table 10-2.

Strategies for Technology Development and Deployment

In Chapters 4 through 7, the *Plan* lays out dozens of technology-specific strategies for research and development for key technologies including, where appropriate, strategies for technology deployment that show promise for realizing such gains. In Chapter 8, the *Plan* addresses the cross-cutting technology area for measuring and monitoring GHG emissions. For each technology area, the *Plan* examines the role that advanced technologies can play in contributing to each CCTP strategic goal, establishes strategic direction for R&D, highlights current R&D activities, and identifies promising directions for future research. A thematic timeline for technology development, evolution and adoption is provided for each of these five CCTP strategic goals.

Figure 10-3 presents an integration of these five timelines, for the near-, mid-, and long-terms. In general, advanced technologies appear in the figure at the point where commercialization is achieved and a favorable investment environment supports their adoption. Although many technologies are shown, only those that offer cost-effective options, compared to their competitors, would achieve significant market representation.

Estimated Timing of Advanced Technology Market Penetrations, as Indicated by the First GtC-Eq./Year of Incremental Emissions Mitigation⁵, by Strategic Goal, Across a Range of Hypothesized GHG Emissions Constraints

CCTP STRATEGIC GOAL	VERY HIGH CONSTRAINT	HIGH CONSTRAINT	MEDIUM CONSTRAINT	LOW CONSTRAINT
GOAL #1. Reduce Emissions from Energy End Use & Infrastructure	2010 - 2020	2030 - 2040	2030 - 2050	2040 - 2060
GOAL #2. Reduce Emissions from Energy Supply	2020 - 2040	2040 - 2060	2050 - 2070	2060 - 2100
GOAL #3. Capture and Sequester Carbon Dioxide	2020 - 2050	2040 or Later	2060 or Later	Beyond 2100
GOAL #4. Reduce Emissions of Non-CO₂ GHGs	2020 - 2030	2050 - 2060	2050 - 2060	2070 - 2080

Table 10-2. Estimated Timing of Advanced Technology Market Penetrations, as Indicated by the First GtC-Eq./Year of Incremental Emissions Mitigation⁵, by Strategic Goal, Across a Range of Hypothesized GHG Emissions Constraints.

5 The years shown in the table represent the period, according to the analysis (Chapter 3), in which the first GtC (or GtC-eq.) of incremental emissions reduction (below an assumed Reference Case) is projected to occur due to the lowest-cost, accelerated adoption of each class of advanced technology in any one of the advanced technology scenarios. The Reference Case, without advanced technology, includes significant penetration of energy-efficient end-use technologies, nuclear, renewable, and biomass energy, terrestrial sequestration and non-CO₂ emission reductions. The table shows ranges of values because results vary among the advanced technology scenarios. "Energy Supply" means net-zero or very low-emissions energy supply technologies.

Climate Change Technology Development and Deployment for the 21st Century ⁶

	NEAR-TERM	MID-TERM	LONG-TERM
GOAL #1 Energy End-Use & Infrastructure	<ul style="list-style-type: none"> Hybrid & Plug-In Hybrid Electric Vehicles Engineered Urban Designs High-Performance Integrated Homes High Efficiency Appliances High Efficiency Boilers & Combustion Systems High-Temperature Superconductivity Demonstrations 	<ul style="list-style-type: none"> Fuel Cell Vehicles and H₂ Fuels Low Emission Aircraft Solid-State Lighting Ultra-Efficient HVACR “Smart” Buildings Transformational Technologies for Energy-Intensive Industries Energy Storage for Load Leveling 	<ul style="list-style-type: none"> Widespread Use of Engineered Urban Designs & Regional Planning Energy Managed Communities Integration of Industrial Heat, Power, Process, and Techniques Superconducting Transmission and Equipment
GOAL #2 Energy Supply	<ul style="list-style-type: none"> IGCC Commercialization Stationary H₂ Fuel Cells Cost-Competitive Solar PV Demonstrations of Cellulosic Ethanol Distributed Electric Generation Advanced Fission Reactor and Fuel Cycle Technology 	<ul style="list-style-type: none"> FutureGen Scale-Up H₂ Co-Production from Coal/Biomass Low Wind Speed Turbines Advanced Biorefineries Community-Scale Solar Gen IV Nuclear Plants Fusion Pilot Plant Demonstration 	<ul style="list-style-type: none"> Zero-Emission Fossil Energy H₂ & Electric Economy Widespread Renewable Energy Bio-Inspired Energy & Fuels Widespread Nuclear Power Fusion Power Plants
GOAL #3 Capture, Storage & Sequestration	<ul style="list-style-type: none"> CSLF & CSRP Post Combustion Capture Oxy-Fuel Combustion Enhanced Hydrocarbon Recovery Geologic Reservoir Characterization Soils Conservation Dilution of Direct Injected CO₂ 	<ul style="list-style-type: none"> Geologic Storage Proven Safe CO₂ Transport Infrastructure Soils Uptake & Land Use Ocean CO₂ Biological Impacts Addressed 	<ul style="list-style-type: none"> Track Record of Successful CO₂ Storage Experience Large-Scale Sequestration Carbon & CO₂ Based Products & Materials Safe Long-Term Ocean Storage
GOAL #4 Other Gases	<ul style="list-style-type: none"> Methane to Markets Precision Agriculture Advanced Refrigeration Technologies PM Control Technologies for Vehicles 	<ul style="list-style-type: none"> Advanced Landfill Gas Utilization Soil Microbial Processes Substitutes for SF₆ Catalysts That Reduce N₂O to Elemental Nitrogen in Diesel Engines 	<ul style="list-style-type: none"> Integrated Waste Management System with Automated Sorting, Processing & Recycle Zero-Emission Agriculture Solid-State Refrigeration/AC Systems
GOAL #5 Measure & Monitor	<ul style="list-style-type: none"> Low-Cost Sensors and Communications 	<ul style="list-style-type: none"> Large Scale, Secure Data Storage System Direct Measurement to Replace Proxies and Estimators 	<ul style="list-style-type: none"> Fully Operational Integrated MM Systems Architecture (Sensors, Indicators, Data Visualization and Storage, Models)

Figure 10-3. Climate Change Technology Development and Deployment for the 21st Century ⁶.

In the near-term (in less than 20 years), the CCTP strategy envisions commercial readiness, such that significant market entry can occur, by hybrid cars, high-efficiency buildings and industrial processes, selected technologies to capture, store and sequester CO₂, coal-based integrated gasification-combined cycle power plants, and methane capture and use technologies. In the mid-term (20 to 40 years later), the early technologies would be followed by significant market shares of hydrogen fuel cell vehicles, “smart” buildings, transformational technologies for energy intensive industries, improved

CO₂ capture, methane emission reductions, and advanced nuclear energy. In the long-term, such technologies would be improved and extended more broadly and more advanced technologies would enter the marketplace. Ultimately, societies could see extensive adoption of low emissions infrastructure and communities, low emissions intelligent transport systems, wide-spread adoption of renewable energy and nuclear power, large scale adoption of zero-emission power plants with carbon sequestration, fusion power plants, and high levels of management of emissions of non-CO₂ GHGs.

⁶ Note: Technologies shown are representations of larger suites. With some overlap, “near-term” envisions significant technology adoption by 10–20 years from present, “mid-term” in a following period of 20–40 years, and “long-term” in a following period of 40–60 years. See also List of Acronyms and Abbreviations.



Figure 10-4. CCTP's portfolio supports near-term deployment of civilian nuclear power, such as Westinghouse's AP1000. Nuclear power safely produces electricity with little or no GHG emissions.

Courtesy: Westinghouse Electric Company, LLC

Key Initiatives

Since early 2002, when CCTP was first organized, there have been a number of portfolio realignments. Foremost among these has been the identification of key technology initiatives that advance multiple technology goals, such as enhancing energy security, reducing air pollution, and promoting economic growth and productivity, while also addressing important thrusts of CCTP strategic goals. These key initiatives complement a core portfolio of technologies in energy efficiency, renewable energy, nuclear power (Figure 10-4), and highly efficient and clean use of coal (Figure 10-5). Although many of the key initiatives are not motivated exclusively by CCTP strategic goals, each is an important contributor to these goals. Collectively, they lend strategic focus and coherence to the many underlying research activities across programs within and among the agencies. They also give visibility to major technology thrusts and complement the regional and international partnerships. Key initiatives are mentioned throughout the *Plan* in their respective technology areas.⁷ A current list of the key initiatives, with links to current programmatic information, may be found at the CCTP Web site.⁸

Contributions of Basic Science

Regarding CCTP's Goal #6 to bolster basic science contributions to technology development, the *Plan* recognizes the critical importance of new knowledge in enabling and accelerating progress in the applied areas. Discoveries in biology, nanosciences, computational modeling and simulation, physical processes, and environmental sciences could result in important breakthroughs for both emissions-related technologies and in measuring and monitoring capabilities. Three strategic thrusts to be pursued by CCTP in basic science include: (1) conducting basic research in areas inspired by the technical challenges in applied climate change R&D; (2) carrying out an exploratory research on innovative concepts and enabling technologies that have great potential for breakthroughs; and (3) improving R&D planning and integrative R&D processes.

Emerging Priorities

The CCTP working groups plan to review regularly the adequacy of the CCTP portfolio to attain CCTP's strategic goals and, where needed, make recommendations to prioritize and strengthen the portfolio, as outlined in Chapter 2. Each goal encompasses many different technologies with varying degrees of GHG reduction potential, likelihood of technological and commercial success, and private sector interest and incentive to invest. CCTP must consider these factors, along with criteria presented in Section 2.4, when recommending priorities for Federal investment.

In this way the CCTP portfolio is strengthened on an ongoing basis. This has resulted in the realignment of the portfolio in certain areas, evidenced by changes in investment levels over time. Climate change strategy also has provided compelling rationales for entirely new or revamped programs. These are described in Chapters 4 through 9 in the current portfolio sections.

Within the overall CCTP portfolio, certain activities are identified as priorities associated with President's National Climate Change Technology Initiative (NCCTI). NCCTI priorities are defined as discrete research, development, demonstration, or deployment activities that address technological challenges that, if solved, could advance technologies with the potential

⁷ See also CCTP Vision and Framework for Strategy and Planning (2005).

⁸ For CCTP-related Key Initiatives, see: <http://www.climate technology.gov>.

to dramatically reduce, avoid, or sequester greenhouse gas emissions. The NCCTI priorities appearing in the Fiscal Year 2007 budget request include, as ordered by strategic goal, the following:

1. Transportation fuel cell systems; solid state lighting; and “Climate Leaders” (Strategic Goal 1).
2. Low wind speed technology, cellulosic biomass (Figure 10-6), biochemical platform R&D, hydrogen storage, nuclear hydrogen initiative, integrated gasification combined cycle (IGCC), and advanced fuel cycle/advanced burner reactor (Strategic Goal 2).
3. Sequestration (Strategic Goal 3).
4. Methane partnership initiatives (Strategic Goal 4).

Also included among the NCCTI priorities is CCTP program support. Details on these activities can be found in Appendix B. Current and updated programmatic information in this regard may be found at the CCTP Web site.⁹

Advances in climate change science under the Climate Change Science Program (CCSP) are expected to improve our knowledge of climate change so that its potential impacts and uncertainties about the causes and effects of climate change will be better understood. This will help to inform the potential risks and benefits of various courses of action. Similarly, advances in climate change technology under the CCTP are expected to bring forth an expanded array of advanced technology options that can meet a range of societal needs, including reducing GHG emissions, with better performance and lower costs. Improved options will enable and facilitate actions that may be called for and informed by science.

Finally, should widespread adoption of advanced climate change technologies be pursued, as guided by science, it would likely need to be supported by appropriate technology policy, potentially including market-based incentives. As Federal efforts to



Figure 10-5. CCTP's portfolio supports the development and demonstration of revolutionary coal-based technologies, such as FutureGen, that is expected to produce electricity, hydrogen, fuels, and chemicals with nearly zero emissions of GHGs.

Courtesy: DOE/FE

advance technology go forward, broadened participation by the private sector in these efforts will be increasingly important to accelerate both the innovation and the commercialization of advanced technologies.

Such participation can be encouraged by appropriate and supporting technology policy. This is evidenced today, in part, by a number of market-based incentives already in place, by others proposed by the Administration,¹⁰ and by still others, as may be appropriate, to GHG-reducing technology investments, soon to be implemented in accord with the provisions of Title XIII of the Energy Policy Act of 2005.¹¹ Title XVI of the Energy Policy Act of 2005 sets the stage for future development of policies that would facilitate new technology adoption. CCTP will support CCCSTI in implementing the provisions of Title XVI. Additionally, CCTP will explore a number of technology policy options, as listed in its next steps below.

10.2 Next Steps

CCTP's next steps focus on a number of broad thrusts. First, the CCTP will continue its coordinating role and provide support to CCCSTI and its IWG. These activities are expected to include multi-agency planning and analysis, portfolio reviews,

⁹ For NCCTI priorities, see: <http://www.climatechange.gov>.

¹⁰ Federal Climate Change Expenditures Report to Congress, April 2006. http://www.whitehouse.gov/omb/legislative/fy07_climate_change.pdf

¹¹ Financial incentives in Title XIII for technologies related to climate change goals are scored at more than \$11 billion over 10 years.



Figure 10-6. CCTP's portfolio supports research to transform switchgrass (shown), other agricultural and forest products, cellulosic plant matter, and associated detritus (e.g., residential waste) into bio-based fuels, which are low in net emissions of GHGs.

Courtesy: USDA NRCS

interagency communications and information exchanges, technical assessments of research needs, and formulating and presenting recommendations. The CCTP will contribute its expertise and provide support to the CCCSTI and IWG as they address issues of climate change science and technology, weigh policies and priorities on related science and technology matters, make informed decisions, and make recommendations to the President and the agencies. Second, the CCTP will continue to work with and support the participating agencies in developing plans and carrying out activities needed to advance CCTP's vision, mission, and strategic goals. Third, CCTP anticipates opportunities to work with technical representatives of other countries to further international cooperation in related planning and program coordination, particularly on joint and multi-lateral technology initiatives.

CCTP intends to pursue specific activities to ensure progress toward achieving CCTP's strategic goals. These activities, organized by approach, are outlined below. CCTP does not expect to pursue all activities immediately, or simultaneously.

Strengthen Climate Change Technology R&D

- ◆ Continue to review, realign, reprioritize, and expand, where appropriate, Federal support for climate change technology research, development, demonstration, and deployment.
- ◆ Periodically assess the adequacy of the multi-agency portfolio with respect to its ability to achieve or make technical progress toward CCTP's strategic goals, identify gaps and opportunities, and make recommendations supported by analysis.
- ◆ In key technology areas, perform long-term assessments of technology potentials, including market considerations and potentially limiting factors.
- ◆ Improve methods, tools, and decision-making processes for climate technology planning and management, and R&D planning and assessment, including tools that allow portfolio planning to address risks through hedging strategies.

Strengthen Basic Research Contributions

- ◆ Establish or improve within each of the participating Federal R&D agencies a process for the integration with, and application of, basic research to help overcome barriers impeding technical progress on climate change technology development (Figure 10-7).
- ◆ Develop means for expanding participation in climate change technology R&D, including relevant basic research, at universities and other non-Federal research institutions.
- ◆ Review agencies' experiences with basic and exploratory research programs aimed at novel, advanced, integrative or enabling concepts not covered elsewhere as a means of stimulating innovation within the research community and enriching the technology R&D portfolio.

Enhance Opportunities for Partnerships

- ◆ Review status and encourage further formation of public-private partnerships as a common mode of conducting R&D portfolio planning and program execution.
- ◆ Encourage formation of non-R&D partnerships.
- ◆ Establish means for enabling and encouraging the secure sharing of potentially sensitive partner information regarding GHG emissions and related performance of GHG-intensity reducing technologies.

Increase International Cooperation

- ◆ Expand international participation in key climate change technology R&D activities and build on the many cooperative international initiatives already underway.
- ◆ Assist the Department of State and CCSP in the coordination of U.S. input and support of Working Group III on Mitigation of the IPCC's periodic Assessment Reports and other technology-related IPCC Special Reports, as means of stimulating international efforts to develop advanced technologies.
- ◆ Support continued efforts to negotiate, execute, and support bilateral agreements¹² that encourage international cooperation on climate change science and technology research. Pursue opportunities for outreach and communication to build relationships and encourage other similar initiatives by other countries.
- ◆ Pursue additional means to enhance the effective use of existing international organizations, such as the Organization of Economic Cooperation and Development, International Energy Agency, Intergovernmental Panel on Climate Change,

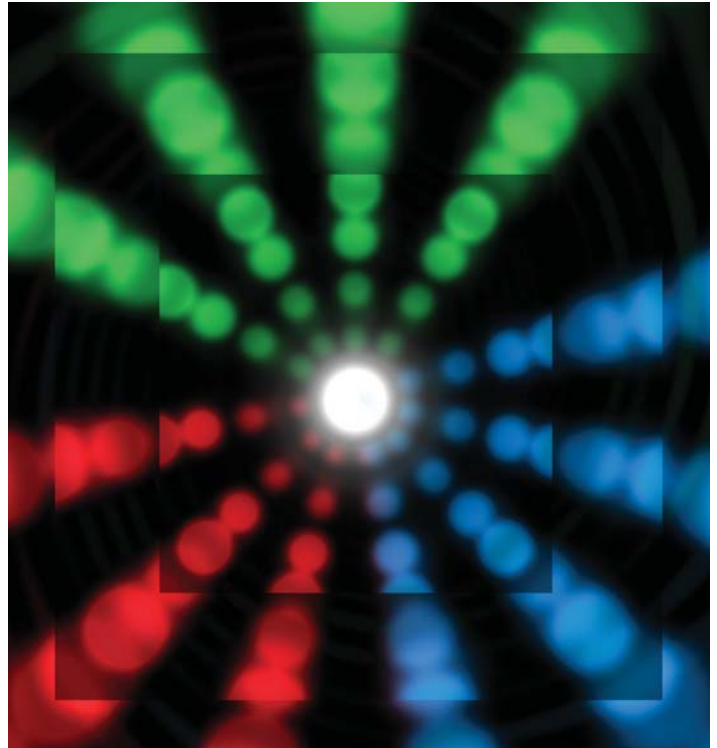


Figure 10-7. CCTP's portfolio supports programs to promote efficiency in energy use, such as advanced lighting concepts including Los Alamos National Laboratory's (LANL) research on white light from inorganic, multi-color light-emitting diodes (LEDs).

Courtesy: DOE/LANL

Group of Eight (G8),¹³ Global Environmental Observing System of Systems, and others, to shape and encourage expanded R&D on climate change technology development worldwide.

- ◆ Develop globally integrated approaches, such as the Asia-Pacific Partnership for Clean Development and Climate (Figure 10-8),¹⁴ to foster capacity building in developing countries, encourage cooperative planning and joint ventures and, enable the development, transfer, and deployment of advanced climate change technology.

¹² The current bilateral agreements are: Australia, Brazil, Canada, China, Central America, Germany, the EU, India, Italy, Japan, Mexico, New Zealand, Republic of Korea, the Russian Federation, and South Africa. The countries included in the Central American agreement, apart from the United States, are: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama.

¹³ The countries are, in alphabetical order, Canada, France, Germany, Italy, Japan, Russia, United Kingdom, and United States. The G8 meetings often include the European Commission.

¹⁴ The Asia Pacific Partnership for Clean Development and Climate was announced in July 2005. Six countries are participating, namely: Australia, China, India, Japan, South Korea, and the United States.



Figure 10-8. Asia-Pacific Partnership on Clean Development and Climate; Second Policy and Implementation Committee and Task Force Meeting, Berkeley, California - April 18–21, 2006, <http://www.asiapacificpartnership.org>.

Courtesy: Asia Pacific Partnership on Clean Development and Climate

Support Cutting-Edge Technology Demonstrations

- ◆ As part of the agencies' regular planning and budgeting processes, consider additional cutting-edge technology demonstrations relevant to CCTP strategic goals.

Ensure a Viable Technology Workforce of the Future

- ◆ Explore the establishment of graduate fellowships for promising candidates who seek a career in climate-change-related technology R&D.
- ◆ Explore possibilities of expanding internships related to climate change technology development in Federal agencies, national and other laboratories, and other Federally Funded Research and Development Centers (FFRDCs).
- ◆ Explore possibilities for establishing CCTP-sponsored educational curricula in K–12 programs related to climate change and advanced technology options.

Provide Supporting Technology Policy

- ◆ Evaluate technology policy options for stimulating private sector investment in CCTP-related research, development, and experimentation activities.
- ◆ Evaluate technology policy options for stimulating private investment in and adoption of advanced climate change technology and other GHG-intensity reducing practices.
- ◆ Support, as needed, policy-related activities undertaken by CCCSTI in furtherance of the Energy Policy Act of 2005.
- ◆ Evaluate various technology policy options for stimulating land-use and land management practices that promote carbon sequestration and GHG emission reductions.

In carrying out these activities, and in accord with its management structure (Chapter 2), CCTP will be advised by the CCTP Steering Group, assisted by its multi-agency CCTP Working Groups, informed by inputs from varied sources, and supported by CCTP staff and resources. Results will be conveyed to the CCCSTI via the IWG. The CCTP also plans to issue periodically reports on its current activities, future plans, and research progress.

10.3 Closing

The United States, in partnership with others, is now embarked on a near- and long-term global challenge, guided by science and facilitated by advanced technology, to address concerns about climate change and increasing concentrations of GHGs. This CCTP *Strategic Plan* is a first step toward guiding Federal investments in R&D to accelerate technologies that will address these concerns. The *Plan* will be updated periodically, as needed.